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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 10/822,345      | 04/12/2004  | Meng Tao             | 124263-1019         | 3116             |

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EXAMINER

RODGERS, COLLEEN E

ART UNIT PAPER NUMBER

2813

| SHORTENED STATUTORY PERIOD OF RESPONSE | MAIL DATE  | DELIVERY MODE |
|--|------------|---------------|
| 3 MONTHS                               | 02/01/2007 | PAPER         |

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

|                              |                                       |                                   |  |
|------------------------------|---------------------------------------|-----------------------------------|--|
| <b>Office Action Summary</b> | <b>Application No.</b><br>10/822,345  | <b>Applicant(s)</b><br>TAO ET AL. |  |
|                              | <b>Examiner</b><br>Colleen E. Rodgers | <b>Art Unit</b><br>2813           |  |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

#### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 06 November 2006.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 1-9, 11-15, 17-19, 21, 22, 24-26 and 28-31 is/are pending in the application.
- 4a) Of the above claim(s) 28-31 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-9, 11-15, 17-19, 21, 22 and 24-26 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)                     | 4) <input type="checkbox"/> Interview Summary (PTO-413)           |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date: _____                                      |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)          | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date: _____   | 6) <input type="checkbox"/> Other: _____                          |

### DETAILED ACTION

1. This Office Action responds to the Amendment filed 6 November 2006. By this amendment, claims 1, 3, 4, 6-9, 12, 14, 15, 17-19, 21, 22 and 24-26 are amended, and claims 10, 16, 20, 23 and 27 are canceled. Claims 1-9, 11-15, 17-19, 21, 22, 24-26 and 28-31 are pending, though claims 28-31 remain withdrawn pursuant to the restriction requirement.

#### *Claim Rejections - 35 USC § 103*

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-9, 11-15, 17-19, 21, 22 and 24-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Herbots et al** (USPN 6,613,677) in view of **Ahn et al** (USPN 6,921,702) and the article by **Boland**, "Structure of the H-Saturated Si(100) Surface," *Phys. Rev. Lett.* **65**(26), 1990, pp. 3325-3328.

Regarding claim 1, **Herbots et al** disclose a method of improving the interface between a dielectric and a semiconductor material comprising the steps of:

passivating a semiconductor surface by forming a layer of a valence-mending agent on the semiconductor surface to eliminate dangling bonds on the semiconductor surface [see col. 9, lines 1-4]; and

performing an oxidation step to form a dielectric on the surface [see col. 9, lines 44-47].

**Herbots et al** do not disclose wherein the valence-mending layer is one atomic layer thick, wherein the valence-mended semiconductor surface substantially retains its semiconductor properties nor wherein the oxidation is accomplished by depositing a precursor to a dielectric on the valence-mended semiconductor surface and oxidizing the precursor. The limitation wherein the valence-mended semiconductor surface substantially retains its semiconductor properties is merely a result of the method, and is considered to be anticipated by the cited art.

Furthermore, while **Herbots et al** disclose that the valence-mending layer (called “passivation layer”) is “ultra thin,” which is defined as 40Å or less, it does not specify that it is one atomic layer thick. However, **Boland** discloses that the coverage for hydrogen on silicon, for instance, is a monolayer. It would have been obvious to one of ordinary skill in the art at the time of invention to deposit a monolayer of the valence-mending agent because **Boland** teaches that it is well-established in the art [see page 3325, col. 1, lines 1-14].

Finally, **Ahn et al** disclose a method of depositing a precursor to a dielectric on a substrate and oxidizing [see, for example, col. 8, lines 57-67]. It would have been obvious to one of ordinary skill in the art at the time of invention to use the metal-precursor oxidation method as taught by **Ahn et al** in the method of **Herbots et al** because **Herbots et al** teach that “all known oxidation processes are expected to satisfactorily perform this final oxidation step” [see **Herbots et al**, col. 9, lines 44-47].

Regarding claim 2, the prior art of **Herbots et al**, **Ahn et al** and **Boland** disclose the method of claim 1 as described above. Furthermore, **Ahn et al** disclose wherein the precursor to a dielectric is hafnium or zirconium, both of whose oxides are a dielectric [see col. 8, line 57 to col. 9, line 12].

Regarding claims 3 and 4, the prior art of **Herbots et al**, **Ahn et al** and **Boland** disclose the method of claim 1 as described above. Furthermore, **Ahn et al** disclose wherein the step of oxidizing is conducted in an oxygen-containing ambient, specifically water vapor and nitrogen [see col. 8, line 57 to col. 9, line 12].

Regarding claim 5, the prior art of **Herbots et al**, **Ahn et al** and **Boland** disclose the method of claim 1 as described above. Furthermore, both **Herbots et al** and **Ahn et al** disclose wherein the substrate may be silicon, germanium or silicon-germanium [see **Herbots et al**, col. 4, lines 15-20; see also **Ahn et al**, col. 2, lines 52-55].

Regarding claim 6, the prior art of **Herbots et al**, **Ahn et al** and **Boland** disclose the method of claim 1 as described above. Furthermore, **Ahn et al** disclose wherein deposition is by thermal evaporation [see col. 9, lines 1-12].

Regarding claims 7, 8 and 11, the prior art of **Herbots et al**, **Ahn et al** and **Boland** disclose the method of claim 1 as described above. None of **Herbots et al**, **Ahn et al** or **Boland** disclose the time for which oxidizing occurs, nor the pressure or temperature at which it occurs. However, these claims are *prima facie* obvious without a showing that the claimed ranges achieve unexpected results relative to the prior art range. *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Huang*, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996) (claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art in general conditions is obvious). In this case, there exists no evidence of record that the oxidation time, pressure or temperature provides

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unexpected results in the dielectric layer produced. One of ordinary skill in the art would be motivated to optimize the oxidation time, the oxidation pressure and the oxidation temperature to provide for processing limitations.

Regarding claim 9, the prior art of **Herbots et al**, **Ahn et al** and **Boland** disclose the method of claim 1 as described above. Furthermore, **Herbots et al** disclose wherein the valence-mending agent (called “passivating agent”) is hydrogen [see col. 9, lines 1-4].

Regarding claim 12, the prior art of **Herbots et al**, **Ahn et al** and **Boland** disclose the method of claim 1 as described above. Furthermore, **Herbots et al** disclose wherein depositing the valence-mended surface is at room temperature [see col. 9, lines 37-41].

Regarding claim 13, the prior art of **Herbots et al**, **Ahn et al** and **Boland** disclose the method of claim 1 as described above. None of **Herbots et al**, **Ahn et al** or **Boland** specifically disclose that the method significantly improves the capacitance-voltage characteristics of the interface between the dielectric and the valence-mended semiconductor surface. However, as this is merely a result of the method, it is considered to be anticipated by the above-cited art.

Regarding claims 14, 15, 17-19, 21, 22 and 24-26, the prior arts of **Herbots et al**, **Ahn et al** and **Boland** disclose the methods as claimed. In the Remarks dated 10 May 2006, Applicants state that, “Species II-A, II-B and II-C are not patentably distinct because each are obvious variants that described a portion of the claimed invention.” This is considered to be an admission that claims 14, 15, 17-19, 21, 22 and 24-26 are obvious over claims 1-9 and 11-13, and therefore are rejected as explained above with reference to the generic claims.

***Response to Arguments***

4. Applicant's arguments filed 6 November 2006 have been fully considered but they are not persuasive. Applicants argue that the reference by **Herbots et al** "does not teach the step of passivating a semiconductor surface using *a valence-mending agent, i.e., the process of valence-mending*" [emphasis in the original]. The Examiner respectfully disagrees. Whether or not **Herbots et al** make use of the term "valence-mending" is immaterial. **Herbots et al** teach the claimed method of terminating dangling bonds on a semiconductor surface in order to improve the interface with a dielectric.

Applicants further claim that "the thickness of the oxide layer is between 0.5 and 10.0 nm, which is significantly greater than the thickness of one atomic layer (approximately 0.15 nm). As such, the oxide layer of Herbots becomes an insulating layer, and thus the semiconductor surface with an oxide layer of a thickness between 0.5 and 10.0 nm loses its semiconductor properties." However, the Examiner points to col. 5, lines 6-11, wherein **Herbots et al** clarify that the dielectric layer "may be as thin as one half to ten nm," but goes on to distinguish this dielectric layer from "the ultra-thin oxide-based coating or interface phase," which is elsewhere disclosed to be a hydrogen layer as described above in the rejection. Furthermore, **Herbots et al** define the term "ultra-thin," as the Examiner previously highlighted above, to mean "having a thickness of 40Å or less" [see col. 6, lines 21-22].

Finally, Applicants argue that "neither the Ahn reference nor the Boland article 'Structure of the H-Saturated Si(100) Surface,' also cited by the Examiner, disclose the step of *passivating a semiconductor surface by valence-mending*" [emphasis in the original]. However, the Examiner contends that the primary reference of **Herbots et al** does disclose the step of passivating by valence-mending, and therefore this argument is moot.

*Conclusion*

5. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Colleen E. Rodgers whose telephone number is (571) 272-8603. The examiner can normally be reached on Monday through Friday, 9:00 AM to 6:00 PM.

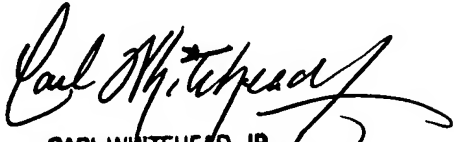
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.



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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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